

CK-12 Understanding Biodiversity

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Wilkin

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Printed: May 29, 2012

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Chapter 1

Understanding Biodiversity: Call for Contributions



A CK-12 & Encyclopedia of Life Publication



Understanding Biodiversity is an on-line repository of biodiversity information intended for the secondary-level life science student. The repository will be compiled with individual species pages which contain information relevant to the secondary science classroom, including cell biology, genetics, evolution, ecology, and physiology.

We invite secondary students to become contributing authors to this FlexBook. Submit proposals for contributions via email to info@ck12.org. Place [SCIENCE] *Understanding Biodiversity proposal* in the

subject line, and include the name of the species for your submission.

After submission of a proposal and upon agreement with *Understanding Biodiversity* editors, students are to use the *Understanding Biodiversity template* to compile information for their selected species. Students may use any available resource to compile their information, including EOL resources. We ask that students identify relevant information as outlined in the template, realizing that some categories will be more extensive for certain species, and that other categories may contain little or no information. Material should be submitted by email to **info@ck12.org**. Place [SCIENCE] *Understanding Biodiversity submission* in the subject line.

See the *Understanding Biodiversity* FlexBook on the CK-12 website (<http://www.ck12.org>) for additional information.

Please email questions to: info@ck12.org.

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Chapter 2

Understanding Biodiversity: Information for Contributors



A CK-12 & Encyclopedia of Life Publication



Understanding Biodiversity is a CK-12 Foundation and Encyclopedia of Life collaborative on-line publication. *Understanding Biodiversity* is a repository of species information relevant for the secondary level life science classroom. This information includes the cell biology, genetics, evolution, ecology, and physiology of individual species. Expeditions relevant to the biodiversity literature will also be featured.

We invite secondary level students to submit **species pages** of organisms studied in the middle school and high school classrooms. **Expedition pages** may also be submitted.

Please submit proposals for contributions via email to **info@ck12.org**. Place [SCIENCE] *Understanding Biodiversity proposal* in the subject line.

The *Understanding Biodiversity* Chapters

Initially, the majority of *Understanding Biodiversity* will be divided into seven chapters - one chapter for each kingdom and one chapter devoted to expeditions. There are also introductory chapters, discussing biodiversity, global climate change and the Encyclopedia of Life. As the repository of information grows, the six kingdom chapters may be divided into a six-volume set, with additional divisions as necessary. However, *Understanding Biodiversity* will be maintained on-line, thus the size of the chapters is not restrictive.

The *Understanding Biodiversity* Species Page

As mentioned above, *Understanding Biodiversity* is a repository of species information relevant for the secondary level life science classroom: cell biology, genetics, evolution, ecology, and physiology. This information will be presented through individual species pages. A **species page** is essentially an individual section of a chapter.

Each species page will contain as much relevant information as feasible. Information will include, but not be limited to,

1. Species Name and Common Name
2. Brief Description of the Organism
3. Brief Description of the Habitat
4. Biology of the Species
 - (a) Cell Biology
 - (b) Genetics
 - (c) Evolution
 - (d) Ecology
 - (e) Physiology
5. Edit History
6. Attribution
 - (a) Authors
 - (b) Affiliations
7. References

See the *Saccharomyces cerevisiae* (Baker's Yeast) species page for an example.

Expedition pages will contain as much relevant information as feasible. Information will include, but not be limited to,

1. Expedition name
 - (a) Brief Description of Expedition
2. The Expedition Leader
3. Biology of the Expedition
 - (a) Description of Significant Findings
4. Edit History

5. Attribution
 - (a) Authors
 - (b) Affiliations
6. References

Potential *Understanding Biodiversity* Species

1. Bacteria
 - (a) *Escherichia coli*
 - (b) *Pseudomonas aeruginosa*
 - (c) *Staphylococcus aureus*
2. Archaea
 - (a) *Halobacterium salinarum*
 - (b) *Methanobrevibacter smithii*
3. Protists
 - (a) *Giardia lamblia*
 - (b) *Paramecium caudatum*
 - (c) *Trypanosoma brucei*
4. Fungi
 - (a) *Agaricus bisporus* (Button Mushroom)
 - (b) *Lobaria pulmonaria* (Lichen)
 - (c) *Penicillium chrysogenum* (Penicillin)
 - (d) *Penicillium roqueforti* (Blue Cheese)
5. Plants
 - (a) *Dionaea muscipula* (Venus Flytrap)
 - (b) *Equisetum arvense* (Horsetail Fern)
 - (c) *Ginkgo biloba* (Ginkgo Tree)
 - (d) *Pisum sativum* (Pea Plant)
 - (e) *Rhizophora mangle* (Mangrove Tree)
 - (f) *Sequoia sempervirens* (Redwood Tree)
6. Animals
 - (a) *Aquila chrysaetos* (Golden Eagle)
 - (b) *Bubo virginianus* (Great Horned Owl)
 - (c) *Didelphis virginiana* (Virginia Opossum)
 - (d) *Elephas maximus* (Asian Elephant)
 - (e) *Gorilla gorilla* (Western Gorilla)
 - (f) *Loxodonta africana* (African Elephant)
 - (g) *Sepia bandensis* (Dwarf Cuttlefish)

Potential *Understanding Biodiversity* Expeditions

1. Amundsen's South Pole Expedition
2. Peary's Conquering of the North pole
3. Cortés' Conquest of Mexico
4. Przhevalsky's Discovery of Central and East Asia

5. von Jacquin's Expedition to the Caribbean
6. Livingstone's Exploration of Africa
7. de Andrade's Exploration of Tibet
8. Hudson's Voyages
9. Humboldt's Expeditions
10. di Mulazzo's North and South America Exploration
11. Nordenskiöld's Northeast Passage
12. Amundsen's Northwest passage
13. Scott's South Pole Expeditions
14. da Gama's Sea Route to India
15. de Magalhães's Voyage of Circumnavigation
16. Darwin's Voyage of the Beagle
17. Cartier's Voyages to the New World

The *Understanding Biodiversity* Template

We have provided a template to assist authors in preparing their contributions. The template should be inserted into a word program, and as much relevant information compiled as feasible. Material should be as thorough as possible, using appropriate grade-level language and vocabulary. The template is available in the *Understanding Biodiversity* FlexBook on the CK-12 website (<http://www.ck12.org>).

Authorship

Contributors should include their name(s) and school affiliations for inclusion in the **List of Contributors**. Appropriate attributions will be determined by the *Understanding Biodiversity* editors. At this time, authorship is limited to secondary-level students.

The Review Process

The *Understanding Biodiversity* review process will involve several stages. Initial review should be by the instructor of the submitting students.

Secondary-level review will be provided by the *Understanding Biodiversity* editors. At this time, the publication may be returned to the contributing student(s) with comments for modification, or the contribution may be submitted for peer-review. It is the intention that published work is subject to a scientific peer-review process. Furthermore, at the discretion of the editors, work may be published prior to the peer-review process, however such work will be noted as *published prior to peer-review*.

Upon acceptance, materials will be published to the *Understanding Biodiversity* site in a timely manner. Contributing authors will be able to site their contributions immediately after publication.

Contributions

Refer to *Understanding Biodiversity: Call for Contributions* for information on submitting material for publication.

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Chapter 3

Understanding Biodiversity: The Encyclopedia of Life



3.1 The Encyclopedia of Life



Figure 3.1: ([Watch Youtube Video](http://www.ck12.org/flexbook/embed/view/1501))
<http://www.ck12.org/flexbook/embed/view/1501>

The **Encyclopedia of Life** (EOL; <http://www.eol.org/>, <http://www.youtube.com/watch?v=6NwfGA4cxJQ>) is a free, online collaborative encyclopedia intended to document all of the 1.9+ million living species known to science. It is aggregated or compiled from existing scientific databases, and from contributions by experts and non-experts world-wide. Its goal is to build one “infinitely expandable” page for each species, including videos, sound, images, graphics, and text. As the discovery of new species is expected to continue (the current rate is about 20,000 new species identified per year), EOL will grow continuously. As taxonomy finds new ways to include species identified by molecular techniques, the rate of new species

additions will increase - in particular with respect to the microbial world of (eu)bacteria, archaeobacteria, and viruses. EOL went live on February 26, 2008 with 30,000 entries and currently has 752,993 entries.

Understanding Biodiversity is made available to the high school student through CK-12 and EOL's collaboration, primarily EOL's Learning + Education group, based in the Museum of Comparative Zoology at Harvard University (<http://education.eol.org/>). *Understanding Biodiversity*, is an expanding library of biodiversity information aimed at the high school biology classroom. Individual *Understanding Biodiversity* species pages will provide information for each species relevant to the high school biology curriculum: cell biology, genetics, evolution, ecology, and physiology. If you would like to submit a species page to *Understanding Biodiversity*, email your proposal for contributions to **info@ck12.org**.



The EOL has developed web-based tools and services that provide visitors enhanced capability to use EOL content for their own purposes and to contribute to the site and become part of a growing international community interested in biodiversity. Some of those tools and services are listed below.

NameLink

<http://www.eol.org/content/page/namelink>

NameLink is a service provided by EOL to quickly identify information associated with taxon names and to provide common species names. Students can submit a webpage address and have the taxon names within the page automatically identified and link up to projects which have information about those names. The common names appear within the webpage or on-line article.

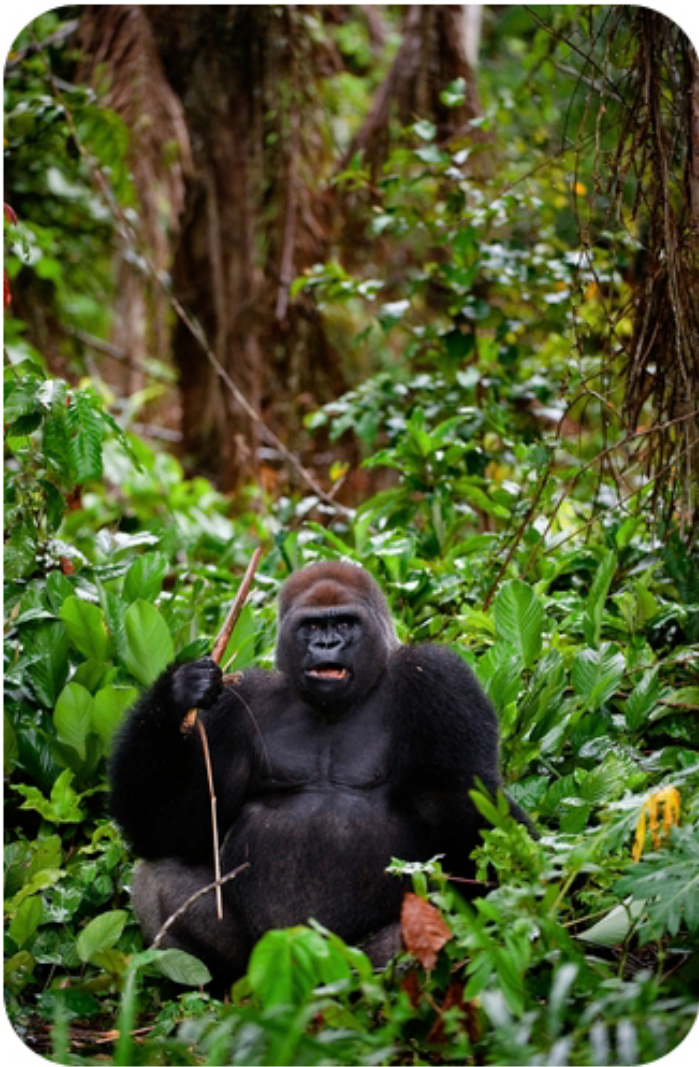
NameLink can be used to identify additional information regarding many species. For example, insert the following URL into the *URL insertion box* on the NameLink page, and explore the information generated by this tool:

A Bioline article and abstract: http://www.mass.gov/dfwele/dfw/nhesp/species_info/mesa_list/mesa_list.htm.

Education LifeDesk

<http://www.edulifedesks.org/>

Register at <http://www.edulifedesks.org/> to join the *CK-12 Biology* group.



A **LifeDesk** is an online environment that provides a collaborative space for creating, editing, and publishing web pages of species information. The goal of using a LifeDesk, in many cases, is to generate content to publish to the EOL, including text and images.

Try using a LifeDesk in a variety of ways. For example, individually or in a small group, research and write or upload images for different sections (e.g., Habitat, Conservation Status, Ecology, etc) of a species page. Alternatively, students can work on the same sections of different species pages and then compare their research findings about the different organisms. Because LifeDesks are on-line, students from different schools or in different locations can collaborate on projects.

When published to EOL, students or classes get credited for the contributions they make to this authentic project. However, there is no requirement to publish content, so LifeDesks can be easily used for class projects that are not visible to external audiences.

LifeDesks have a workflow system that allows groups to set assignments and alert each other when edits have been made or review of work is required. This allows students independence outside of the classroom to work on projects and communicate with their instructors.

Example of student created content published to EOL using an Education LifeDesk: <http://eol.org/pages/790463/overview>.

Field Guides

<http://education.eol.org/ideas/tools/fieldguide>

Field Guides pull selected content from EOL species pages into a format that is easier to view and use for particular projects. Rather than sorting through all 1.9 million species pages and all of the Table of Contents information, users will see information for just the organisms and information they select. Users are able to customize and edit the content in their field guide. Field guides can be made public and print options are available for use in a variety of contexts.

Try creating a field guide for the organisms found in your schoolyard or for the organisms discussed in another chapter of this FlexBook that you are studying. See what information is found in EOL and what is missing. Is there anything you can contribute to EOL, such as an image or some class research information?

Adding Images and Video

You can contribute images of organisms to EOL through popular media sharing sites like Flickr or Wikimedia Commons http://commons.wikimedia.org/wiki/Main_Page. The Encyclopedia of Life Images Flickr group already has over 60,000 images and short video clips, and our members are adding new ones daily.

Basic Flickr accounts are free and it's easy to tag your images for EOL use. See the group page for instructions: http://www.flickr.com/groups/encyclopedia_of_life. EOL harvests the group pool every couple of days, so your images and videos will show up quickly on EOL pages and/or field guides. Uploading images to EOL supports learning of basic technology skills, proper citing of electronic resources and familiarization with scientific and common names for organisms, all while helping to build a global resource.

Short videos can also be uploaded to Flickr. For longer videos, please use EOL's group on Vimeo. <http://vimeo.com/groups/encyclopediaoflife>

BioBlitzes

<http://education.eol.org/bioblitz>

A BioBlitz is a snapshot - a limited-time, limited-space species inventory of the organisms that live in an area. BioBlitzes let people get involved in the natural environment, increasing their awareness of and understanding for the environment. BioBlitzes are conducted to learn more about an area's biodiversity (what different life forms live here?), distribution (where do they live?), and abundance (how many of them are there?).

BioBlitzes can be a source of new information that can be shared with local conservation management groups as well as the EOL.

Students can organize BioBlitzes in their school yards or neighborhood parks. Partner with scientists from local conservation groups or universities to help with identification of species or try your best and see how many different species you can find. Put your event on the BioBlitz Worldwide map <http://education.eol.org/bioblitz/worldwide>, upload your images to EOL, and make a field guide of the species you and your classmates identified.

EOL Podcasts

<http://education.eol.org/podcast>

The audio series *One Species at a Time* is a tribute to life on Earth <http://education.eol.org/podcast/one-species-time>. Each episode is a story, a mystery, a riddle, or an exploration of a different creature pulsing, fluttering, surging, respiring, and galloping on this planet. Biodiversity is center stage, from scurrying invasive beetles in Oregon <http://education.eol.org/podcast/beetles-and-moths> to the threatened cedar trees of Lebanon <http://education.eol.org/podcast/cedar-lebanon> to Ediacaran fauna <http://education.eol.org/podcast/ediacaran> from 580 million years ago. There are associated *Extras* and a *Meet the Scientist* section with each podcast. Some have associated educational materials. All podcasts are freely available and can be used in other projects.

Announcement of the Encyclopedia of Life

<http://www.youtube.com/watch?v=Drtgib0C8hU>



Figure 3.2: ([Watch Youtube Video](#))
<http://www.ck12.org/flexbook/embed/view/2644>

E.O. Wilson: Encyclopedia of Life

<http://www.youtube.com/watch?v=Lj2vRZ6jtAo>



Figure 3.3: ([Watch Youtube Video](#))
<http://www.ck12.org/flexbook/embed/view/2646>

Interview with E.O. Wilson at Harvard University (2011), discussing what he loves about science. <http://education.eol.org/scientists/eo-wilson-podcast-meet-scientist>

3.2 The Biodiversity Heritage Library

<http://www.biodiversitylibrary.org/>

Fourteen major natural history museum libraries, botanical libraries, and research institutions have joined to form the Biodiversity Heritage Library. The participating libraries have over two million volumes of

biodiversity literature collected over 200 years to support the work of scientists, researchers, and students in their home institutions and throughout the world.

The Biodiversity Heritage Library (BHL) consortium cooperates to digitize and make accessible the legacy literature of biodiversity held in their collections and to make that literature available for open access and responsible use as a part of a global “biodiversity commons.” Because of the BHL’s success in digitizing a significant mass of biodiversity literature, the scientific documentation of the study of living organisms since the time of Linnaeus has become easily accessible.

Anyone can access the BHL website directly or link to it from any EOL species page. When on a species page, click on the “References” tab to access literature directly related to the species under consideration.

The published literature on biological diversity has limited global distribution; much of it is available in only a few select libraries in the developed world. These collections are of exceptional value because the domain of systematic biology depends more than any other science-upon historic literature. Yet, this wealth of knowledge is available only to those few who can gain direct access to significant library collections. Literature about the *life* that exists in developing countries is often not available within their borders. Biologists have long considered that access to the published literature is one of the chief impediments to the efficiency of research in the field. Among other results, free global access to digitized versions of the literature would make available information about the Earth’s species to all parts of the world. Many of the texts digitized by the BHL have until now only been held in a few European or North American libraries. Now, with this resource, scientists and student in the developing world have access to them, thereby accelerating biodiversity research.

Since 2009, the BHL has expanded globally. The European Commission’s eContentPlus program has recently funded the BHL-Europe project, with 28 institutions, to assemble the European language literature. Additionally, the Chinese Academy of Sciences, the Atlas of Living Australia, Brazil (through SciELO and BIREME), and the Bibliotheca Alexandrina have created regional BHL sites. These projects will work together to share content, protocols, services, and digital preservation practices.

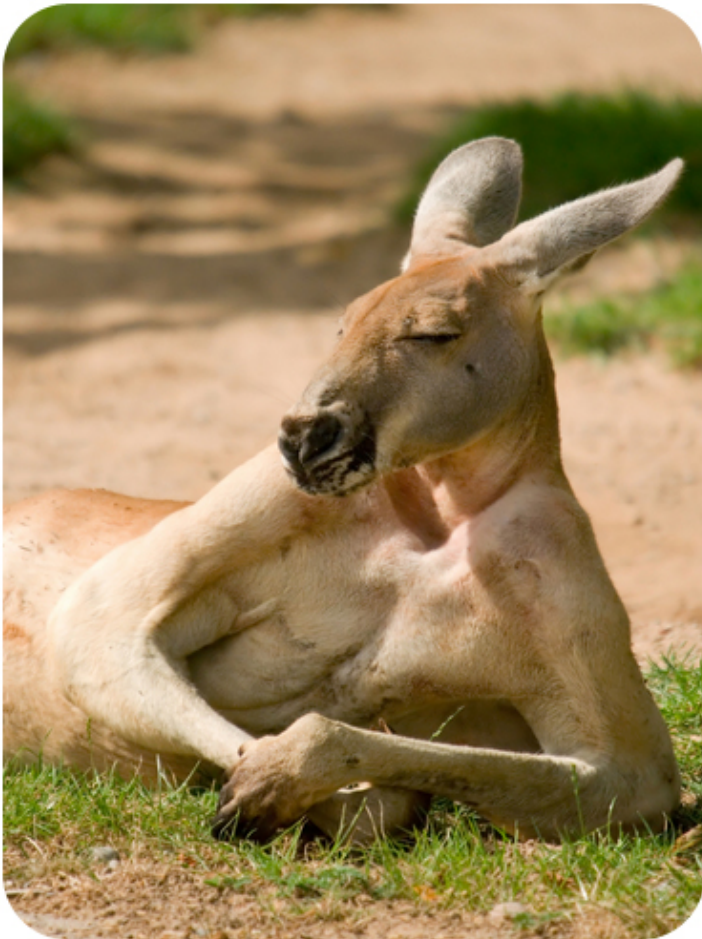


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Chapter 4

Understanding Biodiversity: An Introduction



4.1 Biodiversity

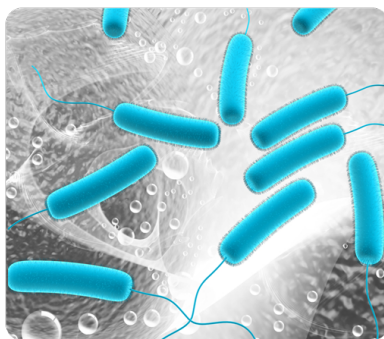
Understanding Biodiversity does not attempt to provide a complete review of biodiversity. For additional information about biodiversity, see the *Communities and Populations* chapter in the

“If names are not correct, language will not be in accordance with the truth of things.”
Confucius.

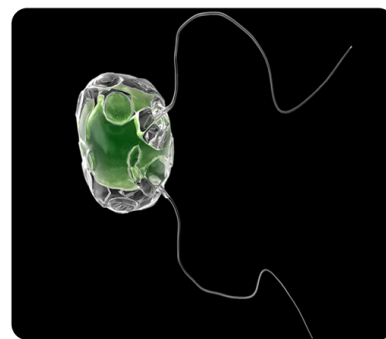
Biodiversity refers to the variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur. Scientists have identified about 1.9 million species alive today, each with their own unique scientific name. They are divided into the six kingdoms of life shown in the **Figure** below. Scientists are still discovering new species. Thus, they do not know for sure how many species really exist today. Most estimates range from 5 to 30 million species.



Archaeobacteria



Bacteria



Protist



Fungus



Plant



Animal

Diversity of life from Archaeobacteria to Plants and Animals.

The Importance of Biodiversity

Human beings benefit in many ways from biodiversity. Biodiversity has direct economic benefits. It also provides services to entire ecosystems.

Economic Benefits of Biodiversity

The diversity of species provides humans with a wide range of economic benefits. Just a few of these are described below:

- Wild plants and animals maintain a valuable pool of genetic variation. This is important because many domestic species are genetically uniform. This puts the domesticated species at great risk of dying out due to disease.
- Other organisms provide humans with many different products, including timber, fibers, adhesives, dyes, and rubber.
- Certain species may warn us of toxins in the environment. When the peregrine falcon nearly went extinct, for example, it warned us of the dangers of DDT.
- More than half of the most important prescription drugs come from wild species. Only a fraction of species have yet been studied for their medical potential. Therefore, declining biodiversity can indirectly harm human health.
- Other living things provide inspiration for engineering and technology. For example, the car design in the **Figure** below was based on the structure of a fish.



The rosy periwinkle is an invaluable source of two important cancer-fighting drugs.



The yellow box fish provided a design model for the car shown here. The fish is the result of millions of years of natural selection for two traits that are also important in cars: efficient aerodynamics and maximum interior space.



From flowers to fish, biodiversity benefits humans in many ways.

Ecosystem Services of Biodiversity

Biodiversity generally increases the productivity and stability of ecosystems. A large biodiversity helps ensure that at least some species will survive environmental change. It also provides many other ecosystem services. For example:

- Plants and algae maintain the atmosphere. During photosynthesis, they add oxygen and remove carbon dioxide.
- Plants help prevent soil erosion. They also improve soil quality when they decompose.
- Microorganisms purify water in rivers and lakes. They also return nutrients to the soil.
- Bacteria fix nitrogen as part of the nitrogen cycle and make the nitrogen available to plants. Other bacteria recycle the nitrogen from organic wastes and the remains of dead organisms.
- Insects and birds pollinate flowering plants, including crop plants.
- Natural predators control insect pests. They reduce the need for expensive pesticides, which may harm people and other organisms.

Why Study Biodiversity?

The economic services and benefits of biodiversity listed above are just a small sample of the reasons to study biodiversity. Every time a species goes extinct or an ecosystem is harmed, it can be argued that we are affected as well. So, as a species, we need to understand as much as we can about other species, especially the niche of other species and how they benefit their ecosystems. Benefits to humans are bound to result from the study of other species.

Millions of Unseen Species

A study released in August 2011 estimates that Earth has almost 8.8 million animal, plant, and fungi species, but we've only discovered less than a quarter of them. Recent newly discovered species have been very diverse: a psychedelic frogfish, a lizard the size of a dime, and even a blind hairy mini-lobster at the bottom of the ocean. There are potential benefits from these undiscovered species, which need to be found before they disappear from the planet. The study estimates that of the 8.8 million species, about 6.5 million would live on land and 2.2 million in the ocean. The research estimates there are 7.8 million animal species, followed by fungi with 611,000 and plants with just shy of 300,000 species. See <http://news.yahoo.com/wild-world-millions-unseen-species-fill-earth-210051661.html> for additional information.

If the 8.8 million estimate is correct, “those are brutal numbers,” said Encyclopedia of Life executive director Erick Mata. “We could spend the next 400 or 500 years trying to document the species that actually inhabit our planet.”

Biodiversity and Human Actions

Over 99 percent of all species that ever lived on Earth have gone extinct. Five mass extinctions are recorded in the fossil record. They were caused by major geologic and climatic events. Evidence shows that a **sixth mass extinction** is occurring now. Unlike previous mass extinctions, the sixth extinction is due to human actions.

Some scientists consider the sixth extinction to have begun with early hominids during the Pleistocene. They are blamed for over-killing big mammals such as mammoths. Since then, human actions have had an ever greater impact on other species. The present rate of extinction is between 100 and 100,000 species per year. In 100 years, we could lose more than half of Earth's remaining species.

Causes of Extinction



This is one of the most powerful birds in the world. Could it go extinct? The Philippine Eagle, also known as the Monkey-eating Eagle, is among the rarest, largest, and most powerful birds in the world. It is critically endangered, mainly due to massive loss of habitat due to deforestation in most of its range. Killing a Philippine Eagle is punishable under Philippine law by twelve years in jail and heavy fines.

The single biggest cause of extinction today is **habitat loss**. Agriculture, forestry, mining, and urbanization have disturbed or destroyed more than half of Earth's land area. In the U.S., for example, more than 99 percent of tall-grass prairies have been lost. Other causes of extinction today include:

- **Exotic species** introduced by humans into new habitats. They may carry disease, prey on native species, and disrupt food webs. Often, they can out-compete native species because they lack local predators. An example is described in the Brown Tree Snake **Figure** below.
- Over-harvesting of fish, trees, and other organisms. This threatens their survival and the survival of species that depend on them.
- Global climate change, largely due to the burning of fossil fuels. This is raising Earth's air and ocean temperatures. It is also raising sea levels. These changes threaten many species.
- Pollution, which adds chemicals, heat, and noise to the environment beyond its capacity to absorb them. This causes widespread harm to organisms.
- Human overpopulation, which is crowding out other species. It also makes all the other causes of extinction more severe.

Brown Tree Snake



Brown tree snakes “hitch-hiked” from their native Australia on ships and planes to Pacific Islands such as Guam. Lacking local island predators, the snakes multiplied quickly. They have already caused the extinction of many birds and mammals they preyed upon in their new island ecosystems.

Brown Tree Snake. The brown tree snake is an exotic species that has caused many extinctions on Pacific islands such as Guam.

Effects of Extinction

The results of a study released in the summer of 2011 have shown that the decline in the numbers of large predators like sharks, lions, and wolves is disrupting Earth’s ecosystem in all kinds of unusual ways. The study, conducted by scientists from 22 different institutions in six countries, confirmed the sixth mass extinction. The study states that this mass extinction differs from previous ones because it is entirely driven by human activity through changes in land use, climate, pollution, hunting, fishing, and poaching. The effects of the loss of these large predators can be seen in the oceans and on land.

- Fewer cougars in the western US state of Utah led to an explosion of the deer population. The deer ate more vegetation, which altered the path of local streams and lowered overall biodiversity.
- In Africa, where lions and leopard are being lost to poachers, there is a surge in the numbers of olive baboons who are transferring intestinal parasites to human who live nearby.
- In the oceans, industrial whaling led a change in the diets of killer whales, who eat more sea lion, seals, and otters and dramatically lowered those population counts.

The study concludes that the loss of big predators has likely driven many of the pandemics, population collapses, and ecosystem shifts the Earth has seen in recent centuries. See <http://news.yahoo.com/loss-big-predators-disrupts-earth-ecosystem-study-181200945.html> for additional information.

Disappearing Frogs

Around the world, frogs are declining at an alarming rate due to threats like pollution, disease and climate change. Frogs bridge the gap between water and land habitats, making them the first indicators of ecosystem changes. Meet the California researchers working to protect frogs across the state and across the world at <http://www.kqed.org/quest/television/disappearing-frogs>. Learn about the plight of the yellow-legged frog at <http://www.kqed.org/quest/radio/plight-of-the-yellowlegged-frog>.



Figure 4.1: ([Watch Youtube Video](http://www.ck12.org/flexbook/embed/view/1531))
<http://www.ck12.org/flexbook/embed/view/1531>

Nonnative Species

Scoop a handful of critters out of the San Francisco Bay and you'll find many organisms from far away shores. Invasive kinds of mussels, fish and more are choking out native species, challenging experts around the state to change the human behavior that brings them here. See <http://www.kqed.org/quest/television/san-francisco-bay-invaders> for more information.



Figure 4.2: ([Watch Youtube Video](http://www.ck12.org/flexbook/embed/view/1532))
<http://www.ck12.org/flexbook/embed/view/1532>

How You Can Help Protect Biodiversity

There are many steps you can take to help protect biodiversity. For example:

- Consume wisely. Reduce your consumption wherever possible. Re-use or recycle materials rather than throwing out and buying new. When you do buy something new, choose products that are energy efficient and durable.
- Avoid plastics. Plastics are made from petroleum and produce toxic waste.
- Go organic. Organically grown food is better for your health. It also protects the environment from pesticides and excessive nutrients in fertilizers.
- Save energy. Unplug electronic equipment and turn off lights when not in use. Take mass transit instead of driving.

Lost Salmon

Because of a sharp decline in their numbers, the entire salmon fishing season in the ocean off California and Oregon was canceled in both 2008 and 2009. At no other time in history has this salmon fishery been closed. The species in the most danger is the California coho salmon. Examine efforts to protect the coho in Northern California and explores the important role salmon play in the native

ecosystem at <http://www.kqed.org/quest/television/californias-lost-salmon> and <http://www.kqed.org/quest/television/coho-salmon-in-muir-woods>.



Figure 4.3: ([Watch Youtube Video](http://www.ck12.org/flexbook/embed/view/1533))
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Chapter 5

Understanding Biodiversity: Global Climate Change



5.1 Global Climate Change and Biodiversity

Understanding Biodiversity does not attempt to provide a complete review of climate change. For additional information about climate change, see the *Communities and Populations* chapter in the CK-12 Biology FlexBook at <http://www.ck12.org/flexbook/book/2537> and the *Ecology and Human Actions* chapter in the CK-12 Biology I - Honors FlexBook at <http://www.ck12.org/flexbook/book/829>.

Does global climate have an effect on biodiversity? How could it not?

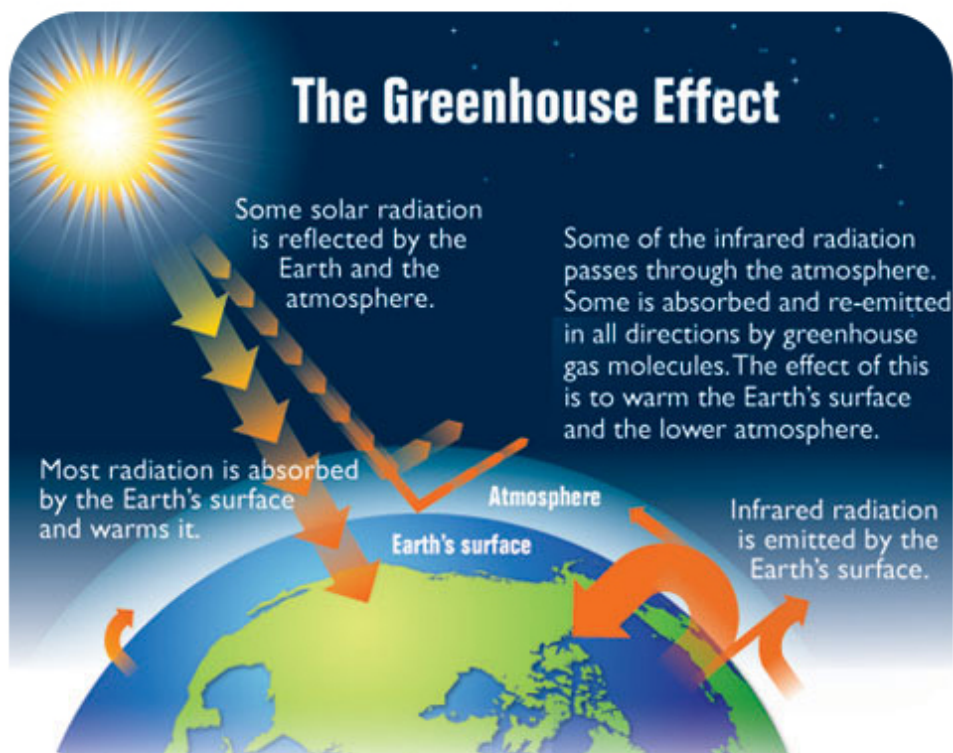
A major problem caused by increased air pollution is global climate change. Global climate change refers to a worldwide significant and lasting change in the distribution of weather patterns over periods ranging

from decades to millions of years. This change may be a change in average weather conditions or the distribution of events that influence the average weather conditions.

What causes this change? It is probable that gases such as carbon dioxide from the burning of fossil fuels increase the natural greenhouse effect. This raises the temperature of Earth's surface. This has numerous consequences. Does this climate change affect biodiversity? Of course it does. And probably in a negative fashion.

What Is the Greenhouse Effect?

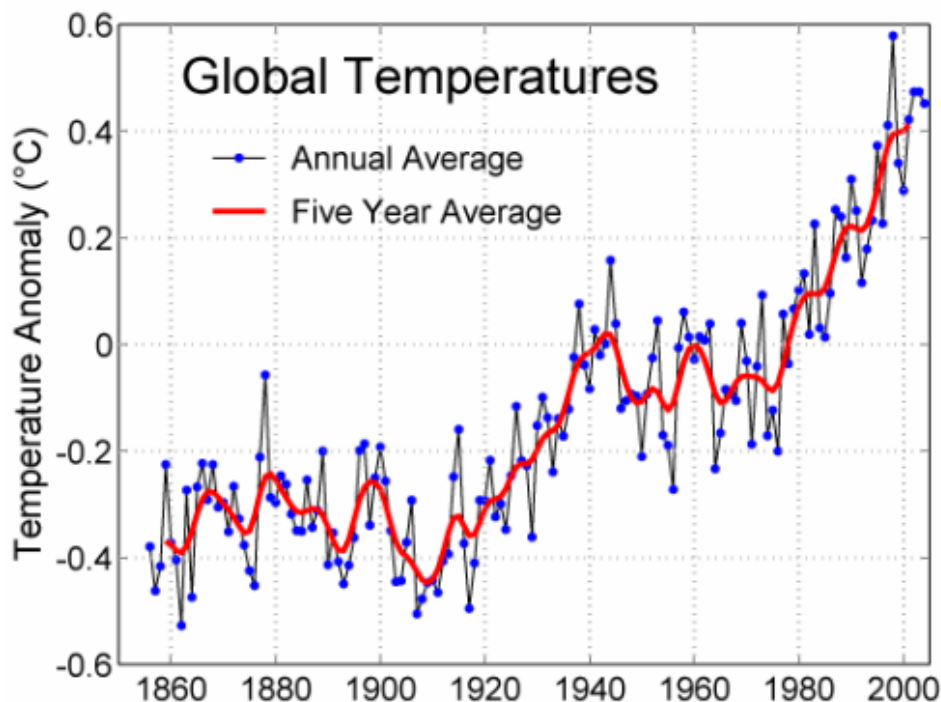
The **greenhouse effect** is a natural feature of Earth's atmosphere. It occurs when gases in the atmosphere radiate the sun's heat back down to Earth's surface (see The Greenhouse Effect **Figure** below). Otherwise, the heat would escape into space. Without the greenhouse effect, Earth's surface temperature would be far cooler than it is. In fact, it would be too cold to support life as we know it.



The Greenhouse Effect. Without greenhouse gases, most of the sun's energy would be radiated from Earth's surface back out to space.

Global Warming

Global warming refers to a recent increase in Earth's average surface temperature (see Global Temperatures **Figure** below). During the past century, the temperature has risen by almost 1°C (about 1.3°F). That may not seem like much. But consider that just 10°C is the difference between an ice-free and an ice-covered Earth.



The average annual temperature on Earth has been rising for the past 100 years.

Most scientists agree that global warming is caused by more carbon dioxide in the atmosphere. This increases the greenhouse effect. There is more carbon dioxide in the atmosphere mainly because of the burning of fossil fuels. Destroying forests is another cause. With fewer forests, less carbon dioxide is removed from the atmosphere by photosynthesis.

Effects of Climate Change

How has global warming affected Earth and its life? Some of its effects include:

- Decline in cold-adapted species populations, such as the polar bears.
- Melting of glaciers and rising sea levels.
- Coastal flooding and shoreline erosion.
- More droughts and water shortages.
- Changing patterns of precipitation.
- Increasing severity of storms.
- Major crop losses.

With Deaths of Forests, a Loss of Key Climate Protectors, (<http://www.nytimes.com/2011/10/01/science/earth/01forest.html>) published October 1, 2011 by the New York Times, discusses the effects of shrinking forests on the global climate. Forests remove greenhouse gases from the atmosphere, and with shrinking forests, less of these gases can be removed. Scientists state that to ensure that forests are preserved for future generations, society needs to limit the fossil-fuel burning that is altering the climate of the world.

In November 2011, the Nobel Prize-winning Intergovernmental Panel on Climate Change issued a special report on global warming and extreme weather (<http://news.yahoo.com/science-panel-ready-extreme-weather-10.html>). They warned of more severe droughts, floods and heat waves due to the warming world. They went

on to further say that without proper preparedness, crazy weather extremes may overwhelm some locations, making some places unlivable.

KQED Quest: Climate Watch: California at the Tipping Point

The world's climate is changing and California is now being affected in both dramatic and subtle ways. In 2008, scientists determined that California's temperatures increased by more than 2.1°F during the last century. What's more, the data showed that human activity has played a significant role in that climate change. "What's just 2 degrees?" you may wonder. But, as the science shows, just 2 degrees is extremely significant.

What does all this temperature change mean? For starters, declining mountain snowpack and prolonged drought conditions could pose a threat to limited water supplies. Heat waves are projected to be longer, bringing increased danger from wildfires and heat-related deaths. Rising sea levels due to temperature shifts jeopardize life in coastal areas, both for human communities and the plants and animals that rely on intertidal and rich wetland ecosystems. Also, more precipitation is expected to fall as rain rather than snow, thereby increasing the risk of floods. And, as heat increases the formation of smog, poor air quality could get even worse.

Climate change may also profoundly affect the economy in California and elsewhere. Shorter ski seasons and damage to the marine ecosystem mean a reduction in tourism. Water shortages mean issues with the commercial and recreational fishing industry, and higher temperatures will affect crop growth and quality, weakening the agricultural industry, to name just a few of the economic issues associated with climate change.

Get an in-depth look at the science behind climate change at <http://www.kqed.org/quest/television/climate-watch-california-at-the-tipping-point-part-one>.



Figure 5.1: ([Watch Youtube Video](http://www.kqed.org/quest/television/climate-watch-california-at-the-tipping-point-part-one))
<http://www.ck12.org/flexbook/embed/view/1534>

KQED Quest: Giant Redwoods and Global Warming

Forest ecologist Steve Sillett is leading a team of scientists as they climb and measure every branch of some of the last and tallest old growth redwoods in California. Their goal is to learn how these ancient giants have historically responded to climatic shifts and to monitor how they are being impacted today by global warming. See <http://www.kqed.org/quest/television/science-on-the-spot-measuring-redwood-giants> for additional information.



Figure 5.2: ([Watch Youtube Video](http://www.ck12.org/flexbook/embed/view/1393))
<http://www.ck12.org/flexbook/embed/view/1393>

KQED Quest: Acidic Seas

Melting glaciers, rising temperatures, and droughts are all impacts of global warming. But how does global warming actually affect the oceans? The sea, it turns out, absorbs carbon dioxide emissions. These emissions are causing the oceans to become more acidic. Changing pH levels threaten entire marine food webs, from coral reefs to salmon.

As you can probably guess, the ocean is an incredibly complex system. So ocean acidification poses an interesting question to scientists: what will the impacts be on marine species and ecosystems? What scientists know already is that some creatures will do fine, while others won't be able to adapt in time. Either way, food webs may feel the effects. Clearly, understanding the potential consequences is important.

Another major concern has to do with marine animals with certain kinds of shells. Corals, clams, and others all use carbonate in the water to build their shells out of calcium carbonate. But ocean acidification reduces the amount of carbonate in the water, making it more difficult for them to make shells. That could be devastating for coral reefs, who are already facing a number of stresses. See <http://www.kqed.org/quest/radio/acidic-seas> for additional information.



Figure 5.3: ([Watch Youtube Video](http://www.ck12.org/flexbook/embed/view/1535))
<http://www.ck12.org/flexbook/embed/view/1535>

What Can Be Done?

Efforts to reduce future global warming mainly involve energy use. We need to use less energy, for example, by driving more fuel-efficient cars. We also need to switch to energy sources that produce less carbon dioxide, such as solar and wind energy. At the same time, we can increase the amount of carbon dioxide that is removed from air. We can stop destroying forests and can plant new ones.

<http://www.youtube.com/watch?v=-gRJLAA4tDY>



Figure 5.4: ([Watch Youtube Video](http://www.ck12.org/flexbook/embed/view/2643))
<http://www.ck12.org/flexbook/embed/view/2643>

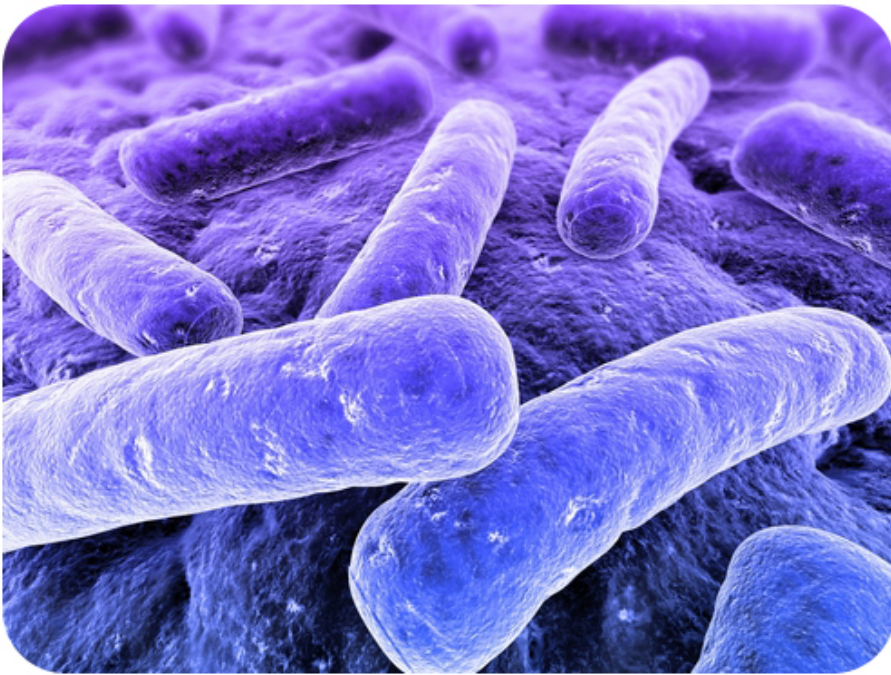
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Chapter 6

Understanding Biodiversity: Bacteria



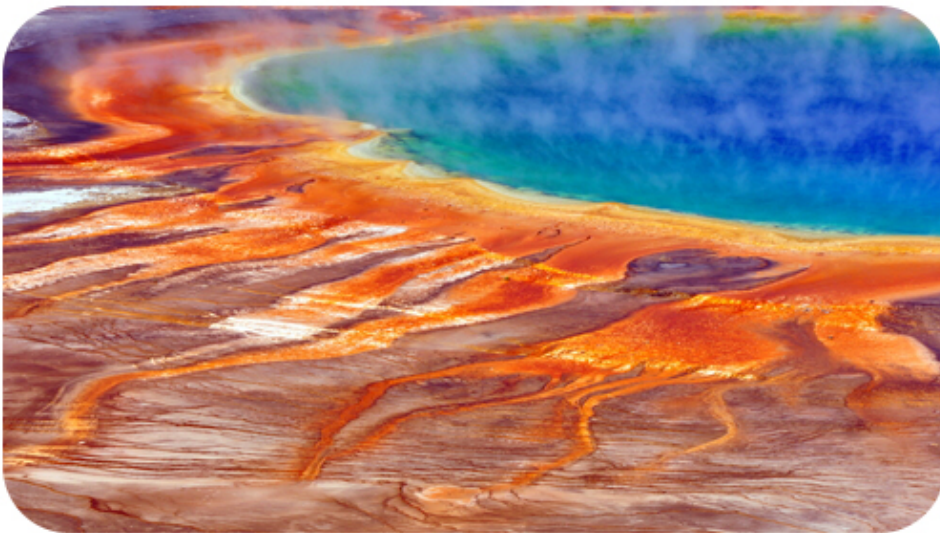
- *Escherichia coli*
- *Pseudomonas aeruginosa*
- *Staphylococcus aureus*

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Chapter 7

Understanding Biodiversity: Archaea



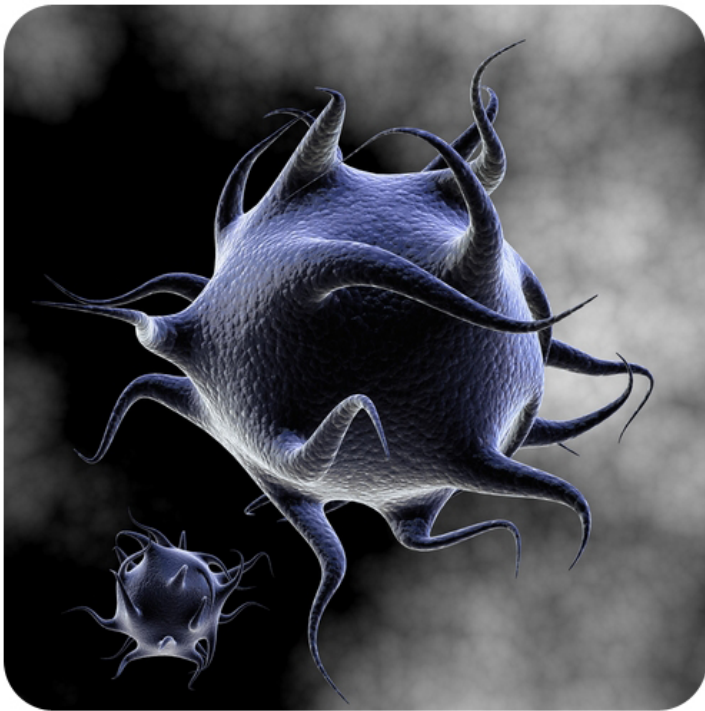
- *Halobacterium salinarum*
- *Methanobrevibacter smithii*

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Chapter 8

Understanding Biodiversity: Protists



- *Giardia lamblia*
- *Paramecium caudatum*
- *Trypanosoma brucei*

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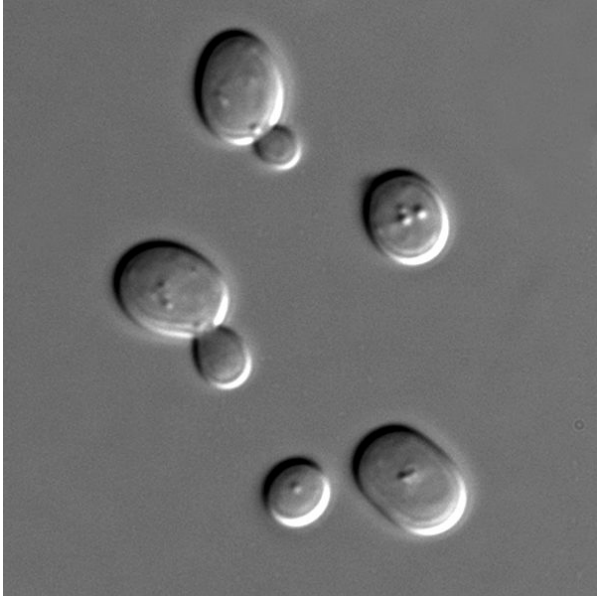
Chapter 9

Understanding Biodiversity: Fungi



- *Saccharomyces cerevisiae* (Baker's Yeast)
- *Agaricus bisporus* (Button Mushroom)
- *Lobaria pulmonaria* (Lichen)
- *Penicillium chrysogenum* (Penicillin)
- *Penicillium roqueforti* (Blue Cheese)

9.1 *Saccharomyces cerevisiae*



Status

reviewed by CK-12

Common Names

- Yeast
- Baker's Yeast
- Brewer's Yeast
- Budding Yeast

Description

Saccharomyces cerevisiae, which in Latin means “sugar fungus,” is a species of the fungi yeast. It is a single-celled eukaryotic organism. *S. cerevisiae* has been instrumental in baking and brewing for thousands of years. *S. cerevisiae* reproduces by budding. Often when using the general term *yeast*, scientists are referring to *S. cerevisiae*.

Saccharomyces is perhaps the most useful and one of the best studied single-celled eukaryotes. As such, *S. cerevisiae* is considered a eukaryotic model organism in molecular and cell biology, and has been instrumental in research on the cell cycle, metabolism, signal transduction, protein interactions, and regulatory networks.

- Domain: Eukarya
- Kingdom: Fungi
- Phylum: Ascomycetes
- Class: Saccharomycetes or Hemiascomycetes
- Order: Saccharomycetales

- Family: Saccharomycetaceae
- Genus: Saccharomyces
- Species: *S. cerevisiae*

Habitat

S. cerevisiae's natural habitat is on the surface of fruit, but it is best known for its role in the baking and brewing industries.

Biology

Cell Biology

S. cerevisiae can exist as both haploid and diploid cells. The haploid cells undergo a simple life cycle of growth followed by mitosis. Under stressful conditions, the cells will die. The diploid cells also undergo growth and mitosis, although under stressful conditions, they will undergo meiosis and produce haploid spores. Under favorable conditions, the spores will then *mate*, producing a diploid cell.

Saccharomyces are heterotrophes, obtaining their energy from glucose, utilizing both aerobic and anaerobic respiration.

S. cerevisiae is a model organism in molecular and cell biology studies. Many signalling pathways of importance in many eukaryotic organisms were first discovered in this species. Many common cell and molecular characteristics of eukaryotic cells were also identified in yeast.

Yeast two-hybrid screening is a molecular biology technique used to discover protein–protein interactions and protein–DNA interactions by testing for physical interactions between two proteins or binding between a single protein and DNA. This technique was developed in 1989, and was originally designed to detect protein–protein interactions using the GAL4 transcriptional activator of *S. cerevisiae*. GAL4 is a nuclear protein, acting as a positive regulator of gene expression for galactose-induced genes. The basic idea behind the test is the activation of downstream reporter gene(s) by the binding of a transcription factor onto an upstream activating sequence (UAS) on the DNA.

Genetics

The genome of *S. cerevisiae* was the first eukaryotic genome that was completely sequenced. The sequence was released to the public on April 24, 1996. The genome is composed of about 12,156,677 base pairs and 6,275 genes, distributed on 16 chromosomes. Only about 5,800 of these genes are believed to be functional. This species is estimated to share about 23% of its genome with that of humans.

One of the first groups of growth mutants isolated from yeast were those that required adenine, one of the bases in DNA and RNA nucleotides and a component of ATP. There are several genes in yeast that are involved in adenine synthesis, and a mutation in any one of these genes requires that adenine be added to the growth medium. The first two adenine-requiring mutants discovered were in yeast, and are known as *ade1* and *ade2*. The functional alleles of these genes are the *ADE1* and *ADE2* genes.

Evolution

Recent studies estimate the arrival of fungal organisms at about 760–1060 million years ago (Ma) on the basis of comparisons of the rate of evolution in closely related groups. For much of the Paleozoic

Era (542–251 Ma), fungi lived in water. Moving onto land required fungi to develop other methods to obtain nutrients, including parasitism, saprobism, and the development of mutualistic relationships, such as mycorrhiza and lichen. Recent studies suggest that the ancestral ecological state of the Ascomycota was saprobism.

The fungi probably colonized the land during the Cambrian (542–488.3 Ma), long before land plants. Fungal fossils do not become common until the early Devonian (416–359.2 Ma). At about this same time, approximately 400 Ma, the Ascomycota and Basidiomycota diverged. Yeast is a member of the phylum Ascomycota.

Ecology

Physiology

S. cerevisiae can exist as both haploid and diploid cells. Haploid *S. cerevisiae* cells exist as two mating types: **a** and **α**. Both haploid and diploid *S. cerevisiae* cells may reproduce asexually by budding. But yeasts, like all fungi, may have also have sexual reproductive cycles. Under stressful conditions, haploid cells will generally die; but under the same conditions, diploid cells can enter sexual reproduction processes. Under stressful conditions, diploid yeast cells, can undergo meiosis to produce four haploid spores: two **a** spores and two **α** spores. Upon favorable conditions, cells of opposite mating type can fuse to form a diploid cell. There are two alleles that determine the mating types of haploid strains. Alternative alleles of the *MAT* gene, *MATa* and *MATα*, determine the two opposite mating types.

Yeast have simple nutritional requirements. As yeast are fungi, they are unable to carry out photosynthesis. They obtain their carbon from carbon containing compounds, which can be as simple as the two-carbon acetate. In addition, they also require a source of nitrogen, which can be as simple as the single-nitrogen containing ammonium sulfate. Yeasts can also use a variety of organic nitrogen compounds containing both carbon and nitrogen, such as urea and various amino acids. The only other complex compound that yeast require is the vitamin, biotin. In addition, they also require more simple molecules including a variety of salts and trace elements.

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Attribution

Authors

Affiliation

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Edit History

Created: November 18, 2011

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Chapter 10

Understanding Biodiversity: Plants



- *Pisum sativum* (Pea Plant)
- *Dionaea muscipula* (Venus Flytrap)
- *Equisetum arvense* (Horsetail Fern)
- *Ginkgo biloba* (Ginkgo Tree)
- *Rhizophora mangle* (Mangrove Tree)
- *Sequoia sempervirens* (Redwood Tree)

10.1 *Pisum sativum*



Status

Published prior to review.

Common Name

- Pea Plant
- Garden Pea

Description

Scientifically, the pea plant *Pisum sativum* may be one of the most important members of the plant kingdom. This plant was used by Gregor Mendel, the father of genetics, to develop the basic concepts of inheritance.

The pea plant, like all angiosperms, is classified as an autotroph, meaning it uses photosynthesis to convert the energy of the sun to glucose. This plant has been cultivated across the world for thousands of years. Also, it is a legume, so it has the ability to fix nitrogen through a symbiotic relationship with the bacteria, *Rhizobium*.

Pea Plants are useful for studying heredity due to the duality of their various phenotypes. For example, their flower color is purple or white, the seed form is round or wrinkled, or the stem is tall or short. This means that there are no intermediate phenotypes. Also, the male and female reproductive parts of the plant are enclosed in the same flower, and mating/pollination can be controlled. It can also grow easily

and mature in a short period of time, which allows results to be obtained quickly. Mendel studied about 29,000 pea plants during his studies.

The taxonomic classification of *P. sativum* is as follows:

- Domain: Eukarya
- Kingdom: Plantae
- Phylum: Anthophyta
- Class: Eudicotyledones
- Order: Fabales
- Family: Fabaceae
- Genus: *Pisum*
- Species: *P. sativum*

Habitat

The pea plant can be grown in any area with moderate temperatures; it isn't localized to any one ecosystem or biome. *P. sativum* can be found across the world today either in garden's for personal use or for commercial sale. The plant is native to the eastern Mediterranean areas and began to grow in rocky areas, from the regions of Turkey east to Syria, Iraq, and Iran. The pea plant thrives at temperatures between 13-18°C (55-64°F), developing best in the spring, cool summers, or the beginning of fall.

Biology

Cell Biology

Like all plants, *P. sativum* is an autotroph, absorbing sunlight to start the photosynthesis process. Together with carbon dioxide and water, the plant produces glucose, releasing oxygen as a waste product. The pea plant is also known as a producer, forming the energy that will benefit itself and other organisms in the ecosystem. This energy is stored within the plant as the carbohydrate starch, which is a polysaccharide of thousands of glucose molecules bonded together.

The pea plant, like all vascular plants, uses a vascular system comprised of phloem and xylem to transport water, sugars and other substances. The pea plant cells have a central vacuole used to store water. The phloem is used to transport sugars and nutrients. The xylem is used to transport water.

Genetics

P. sativum has a large and complex genome. It contains 4,300 mega base pairs or 4,300,000,000 base pairs. The *P. sativum*'s genome contains 14 chromosomes. The Pea Plant was used by Gregor Mendel to develop of his two laws of genetics. These principles of Mendelian genetics are the foundation of modern genetics.

Mendel investigated seven different characteristics in pea plants including seed shape, flower color, stem size, pod shape and pod color. Mendel cross-pollinated pure-bred parent plants, referred to as the P-generation. The offspring of the P generation, called the F1 generation, all had phenotypes representing one parental characteristic. When individuals from the F1 were allowed to self-pollinate, the next generation, the F2 generation, had 3 of 4 individuals with one P generation characteristic, and 1 of 4 individuals with the other P generation characteristic. This led to Mendel's law of segregation. This law states that there are two factors controlling a given characteristic, one of which dominates the other, and these factors separate and go to different gametes when a parent reproduces.

Additional experiments analyzing two pea plant characteristics, such as pod shape and color, resulted in Mendel developing his second law, the law of independent assortment. This law states that factors controlling different characteristics are inherited independently of each other.

Evolution

Evolutionary scientists believe that the *P. sativum* first evolved in Egypt in the Nile Delta area around 4800-4400 BC. The Pea Plant has not evolved over time or from a specific organism but it has made adaptations. The adaptations that it has made over time are self-pollination, nitrogen fixation, and the development of xylem and phloem. Self-pollination allows the pea plant to reproduce without the need of an organism to move its pollen. The downside to self-pollination is that there is less of a chance for greater genetic variability and change.

Ecology

The pea plant's ecological role in the environment is a producer.

The pea plant is able to carry-out nitrogen fixation because of a symbiotic relationship with certain bacteria and fungus. The bacteria receive extra sugars that the pea plant has made through photosynthesis, and the bacteria provides the plant with nitrogen. The plant, like all organisms, incorporates the nitrogen into its nucleic acids. The fungus provides the plant with additional nutrients that it usually receives from the soil. The fungus also receives glucose from the plant.

Physiology

Like all plants, *P. sativum* has an alternation of generations life cycle. This type of life cycle has separate times when either the haploid or diploid organism is dominant. Like all angiosperms, the pea plant has separate male and female reproductive structures, though both are located in the same flower.

Like most vascular plants, *P. sativum* maintains homeostasis through the use of xylem and phloem, self-pollination, and nitrogen fixation. Since the pea plant is a legume, it has developed a relationship with the bacteria *Rhizobium*. This bacteria enters the roots of the pea plant and forms nodules. Through this symbiotic relationship, the bacteria receive carbohydrates and other substances in exchange for fixing/converting nitrogen gas. The pea plant obtains and produces glucose during the process of photosynthesis, which it supplies to the bacteria. The pea plant has also developed a symbiotic relationship with a fungus. The fungus provides the plant with additional nutrients from the soil, and the fungus receives sugars from the plant.

The development of plant vascular tissue, xylem and phloem, occurred when plants migrated onto land. This vascular system allowed for the movement of water up the plant, and sugars made in their leaves during photosynthesis down the plant. The xylem moves water and the phloem moves dissolved solutes like sugars and amino acids. With this adaptation, the pea plant, like all plants is able to grow taller.

Photosynthesis converts water and carbon dioxide into sugars and oxygen, with the help of sunlight. *P. sativum* has two separate layers in the walls of the pods that are involved in photosynthesis. The outer layer is used to collect carbon dioxide from the atmosphere, and the inner layer is used to collect carbon dioxide that is coming off from the developing seeds inside the pod.

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Edit History

- Created: May 25, 2012
- Version 1.0 submitted to CK-12: May 25, 2012
- CK-12 edits: *in progress*

Image Sources

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Chapter 11

Understanding Biodiversity: Animals



- *Loxodonta africana* (African Elephant)
- *Phascolarctos cinereus* (Koala)
- *Delphinapterus leucas* (Beluga Whale)
- *Lemur catta* (Ring-Tailed Lemur)
- *Sepia bandensis* (Dwarf Cuttlefish)
- *Aquila chrysaetos* (Golden Eagle)
- *Bubo virginianus* (Great Horned Owl)
- *Didelphis virginiana* (Virginia Opossum)
- *Elephas maximus* (Asian Elephant)
- *Gorilla gorilla* (Western Gorilla)

11.1 *Loxodonta africana*



Status

Published prior to review.

Common Name

- African Elephant
- African Bush Elephant
- African Savanna Elephant

Description

The African Bush Elephant, scientifically classified as *Loxodonta africana*, is an organism under the Eukarya domain and present in the animal kingdom. Its full biological classification is

- Kingdom: Animalia
- Phylum: Chordata
- Class: Mammalia
- Order: Proboscidea
- Family: Elephantidae
- Genus: *Loxodonta*
- Species: *L. africana*

Physically, the African Bush Elephant is the largest land living animal alive today, with the male weighing around 15,000 pounds and reaching a length of about 6 to 7.5 meters (about 20-25 feet), and a shoulder height of 3.3m (over 10.5 ft). Females are much smaller, reaching 5.4 to 6.9m (about 17.5 to over 22 ft) in length, and 2.7m (almost 9 ft) in height at the shoulder, and weighing around 6,600 pounds.

Regarding its diet, the African Bush Elephant is a herbivore, consuming various types of plants. The average elephant from this species consumes about 225 kilograms of food daily, and it actively washes down its food with nearly 200 liters of water.

Socially, the African Bush Elephant interacts immensely with other elephants of its kind, associating in groups to protect each other from predators. Among these groups, the elephants mate with each other.

The female emits mating calls from her trunk when she is receptive and ready to mate. The female is pregnant for roughly twenty two months.

Habitat

L. africana are present the continent of Africa, which is susceptible to climates of high temperature and sunlight. Specifically, the African Bush Elephant is commonly found in the central and the southern regions of the African continent, where they inhabit the plains and the multiple grasslands/savannahs present in this region. Both of these habitats express an abundance of grass but relatively few trees, and are sometimes surrounded by water springs. The climate of the savannah is hot during the summer, with occasional rainfall in either the summer or the winter seasons. With the rainfall, water holes and small ponds accumulate in the habitat, yet there is not enough rainfall to completely promote the growth of many trees in the habitat. Other animals that live in the savannah and grassland habitats alongside the elephants include the black mamba, the lion, the zebra, the Nile crocodile, and many other animals.

Biology

Cell Biology

L. africana is capable of producing both haploid and diploid cells. Haploid cells are produced by cells in the organism's reproductive system, where these cells divide by the process of meiosis, forming four gamete cells for each starting cell that undergoes this process. Male gametes (sperm), and female gametes (eggs), come together during fertilization to form a diploid zygote, with double the genetic material of haploid cells. Diploid, or somatic cells, which consist of the elephant cells excluding gametes, replicate by mitosis in order to promote the growth and envelopment of the elephant and its internal organs and organ systems.

L. africana is a heterotrophic organism, consuming autotrophs, including many different types of vegetation. Like other animals, *L. africana* obtains energy by breaking down organic molecules via cellular and aerobic respiration.

In addition, *L. africana* has the unique facet of large red blood cells present in its circulatory system. These large cells naturally have a higher affinity for oxygen due to an increased amount of hemoglobin, the protein in the red blood cells that is responsible for carrying oxygen throughout the elephant's body. This high affinity for oxygen greatly increases the efficiency of cellular respiration in the organism.

Genetics

The genome of the *L. africana* is very important, as its unique composure is able to distinguish it from the very similar genome of the African Forest Elephant, *L. cyclotis*. Through consecutive analysis of both of the genomes, together with a comparison of the genomes of the Woolly Mammoth and Mastodon, numerous species differences can be observed. Differences in the base sequences of the two elephant's genomes proved that both of these elephants were in fact, distinct species. In 2010, sequencing efforts proved the two elephant species to be distinct. The DNA sequencing of 375 genes, demonstrated that the two species diverged around the same time as the Asian elephant and the woolly mammoth around 2.6 to 5.6 million years ago.

Evolution

L. africana is part of the Mammalian class, where its ancestors were the largest land dwellers, having originated about 60 million years ago. One of the first ancestors that the *L. africana* originated from was the Moeritherium, which lived about 37 million years ago and is considered one of the first ancestors of the African Bush Elephant. The Moeritherium was the ancestor that created the transition between aquatic and terrestrial inhabitation, living the lifestyle similar to a hippo, yet slowly inclining towards inhabiting land itself.

One of the next ancestors of *L. africana* after the Moeritherium was the Gomphotherium, which inhabited terrestrial land about 10 million years ago. This ancestor of the *L. africana* had now evolved from the Moeritherium by means of adapting to a much more fully terrestrial lifestyle. Acquired characteristics in exposure to land habitats included tusks to defend itself from terrestrial predators on both its upper and lower jaws. Its jaws also evolved to a much more durable shape in order to help digest vegetation that this organism consumed on land.

Finally, the Gomphotherium evolved into two separate species, the Mastodon and the Woolly Mammoth. Both of these species of animals specialized in the development of strong tusks fashioned out of ivory in their upper jaw. Both of these species became extinct during the Ice Age about 12,000 years ago, with more modern elephants now arising from these ancestors to form the three current species of elephants present today in our world; the African Bush Elephant, the African Forest Elephant, and the Asian Elephant.

Ecology

L. africana species interacts with its woodland and savannah environments in many different ways that make up its overall ecological background. We see that the African Savannah Elephant, in order to obtain food and resources, such as vegetation to consume or water to drink, must interact with their environment in many ways to do so. For instance, the African Bush Elephant is active either day or night, looking for food and resources at both of these time periods. The African Bush Elephant sleeps and uses periods of rest to restore its energy needed to scavenge the environment for resources. *L. africana* may also embark frequently on long migrations of up to several miles to find water to drink in order to survive.

In order to receive protection from predators of the habitat, the African Bush Elephant actually congregates in matriarchal, or female led packs of about ten or more elephants. Between the ages of 8 and 20 years, the male elephants in a pack are abandoned. Once puberty begins in the male, the males can live alone without the aid of the pack. While this occurs, the male African Bush Elephant enters a state of mating classified as musth, a complex state of arousal that is triggered by an increased amount of the hormone of testosterone. This increased amount of testosterone causes male elephants to become aggressive and at the same time trigger an increase in sexual activity in these elephants. This state of musth lasts a few days to about a month in male elephants, but it is enough to promote conception of a future generation of elephants during mating season. After mating, a female elephant, now impregnated by the male, has to undergo a very long period of gestation of 22 months before giving birth to a young elephant.

Finally, the African Bush Elephant serves a very important niche in the savannah and the woodland. For example, this species of elephant converts areas of the forest into grassland by modifying the terrain in order to aid their search for food. Finally, the African Bush Elephant actually digs holes in the ground as they travel through their habitat, which provide areas where water can collect, providing water for other animals to consume.

Physiology

L. africana, the largest living terrestrial animal in the world, possesses several unique features that truly distinguish it from other species of elephants in Africa and Asia. Male elephants possess a length that ranges from 6 to about 7.5 meters, while females are much smaller, with a length of about 5.4 to 6.9 meters. The males are also much heavier, weighing a full 7 tons on average (about 15,000 pounds), while females weigh less at around 3 tons (about 6,000 pounds) on average.

Features in the African Bush Elephant's body are also adapted to suit the needs of the survival of this species in this habitat. This species of elephant possesses 2 large and flappy ears, which enable excess heat to radiate out of the elephant's body, cooling its internal body temperature in the hot savannah habitat. In addition, the African Bush Elephant has thick strong skin that prevents parasites and other small bugs of the savannah habitat from infecting it with deadly diseases. Along with its skin, the African Bush Elephant has a very long and powerful trunk made purely out of muscle that allows this organism to obtain and store water for consumption at a later time. Two large ivory tusks at opposite ends of the elephant's jaw help the elephant move powerfully through objects obstructing its path in the savannah, and in some cases, are utilized as a defense mechanism against predators, such as lions or cheetahs.

Finally, the African Bush Elephant's internal body system has adapted functionally to the vegetarian diet of the organism. Four large molars in the elephant's jaw enable it to chew and thoroughly digest its food before it is sent to the digestive organs of the elephant for further digestion. The digestive system of the African Bush Elephant, which is specifically modified for a vegetative diet via specialized digestive juices and enzymes, eventually absorbs the nutrients of the food the elephant consumes, and disposes the waste of the food as nutrient rich waste. This soon fertilizes the savannah land and allows for more vegetative growth, allowing the food cycle of the African Bush Elephant to continue for generations to come.

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Attribution

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Edit History

- Created: November 29, 2011
- Version 1.0 submitted to CK-12: May 25, 2012
- CK-12 edits: *in progress*

11.2 *Phascolarctos cinereus*



Status

Published prior to review.

Common Name

- Koala

Description

With fur so pleasantly touchable and eyes as black as night, the koala has indeed been one of the world's most fascinating creatures. The koala originally acquired its unique name in the eighteenth century when Europeans arrived in Australia. When in Australia, the Europeans became familiar with the foreign creature and they soon discovered that the Aboriginal people had already identified the koala with words such as: cullawine, koolewong, koolah, kaola, karbor, boorabee and so forth. The word *koala* originates from the language of Katang, sometimes described as meaning “no water” or “does not drink.” Undeniably, koalas are not known to drink water for they replenish their dehydrated bodies with the water from the leaves of eucalyptus trees. Koalas generally live an average of 13-17 years and females often live longer than males, whose life expectancy is often less than 10 years due to injuries during fights, attacks by dogs, and being hit by cars.

Alongside their modest nature and enchanting personality, *Phascolarctos Cinereus* are described to be usually ash grey with a white chest. They have very thick fur, fluffy ears (with long white hairs on the tips) and an extensive flat nose. Their strong limbs and large hands help them to climb trees, which also provide their main source of food. Koalas are, in fact, not bears but marsupials. The genus and species name together, *P. cinereus*, translates to “ash colored pouched bears.” The complete taxonomic classification is:

- Kingdom: Animalia
- Phylum: Chordata
- Class: Mammalia
- Infraclass: Marsupialia

- Order: Diprotodontia
- Family: Phascolarctidae
- Genus: *Phascolarctos*
- Species: *P. cinereus*

Habitat

Koalas inhabit the large Eastern part of Australia and can be found in greater numbers in the Northeast and Southeast of this vast territory. The koala is an arboreal animal which means “living in trees”. But koalas live only in certain types of trees, called eucalyptus trees, where they eat the leaves. Their distribution has a lot to do with the type of eucalyptus that exists in each area. Koalas are highly specialized to survive only in one type of habitat: in woodland areas with plenty of eucalyptus trees, also known as gum trees. These habitats provide the koala with food, water, safety from ground predators, and all other needs. Koalas do not have dens, tree-holes, or nests. They sleep, eat, and breed on the branches. Unlike most mammals, koalas never make dens or permanent homes. They do have home territories, but they will not stay in one particular tree. Male koalas have a special area on their chest that leaves a scent. They rub their chests on their “home trees” to leave their scent and mark the trees as their own.

Biology

Cell Biology

Genetics

The Koala, which resembles a type of bear and was given the name “koala bear,” is definitely not a bear. Although new information has proved that the koala is not a bear, this animal is still referred to as a bear. The complex genetics of this animal proves its uniqueness. Koalas are the only living member of their family.

Evolution

Marsupials belong to a class of animals that are among the oldest inhabitants of our planet. Koalas go back over 5 million years, in fact, to the period before the separation of the land masses into what we recognize today as the continents. There are three subspecies of the koala. First, are the Northern koalas (*P.c. adjustus*) which are found in the state of Queensland in northeast Australia. They weigh around eleven to seventeen pounds, with short silvery gray fur. Second, are the Southern koalas (*P.c. victor victoria*) in the state of Victoria and the males are at times twice as large as Northern koalas, weighing at about twenty six pounds, while females are a little smaller at seventeen pounds. The southern koalas have much thicker cinnamon-colored fur used as shield from the harsh cold weather. The last subspecies (*P.c. cinereus*) with their grayish fur are located in New South Wales, which lies in between Victoria and Queensland.

Other subspecies of koalas have been discovered in southern Australia, with fossils dating back 2 to 5 million years. Some fossil finds have shown that the koalas were twice as large as koalas nowadays. These wonderful remnants have provided scientists with clues about prehistoric koalas. In 1953, the teeth and jaw fragments of a cousin of the modern koala were found in a site dating back 24 million years in central Australia, which show us that earlier koalas also lived in trees and ate tree leaves.

Ecology

The koala, which is an exceptional tree hugger, can be found only in areas like forests and woods. Not only do they survive on the leaves given by the preferred eucalyptus trees, but they eat only a small percentage of the many eucalyptus trees in the world. With their picky diet and limited environment, the koalas must continuously adapt to their habitat.

Koalas can endure many types of weather change. Their fur coats protect from the harsh bitter cold and from the sweltering heat, which is occasionally found in their areas. Amazingly enough, the female koala has a pouch where their offspring crawl into during the first 6 months of their lives. It is in this pouch that the newborn koala feed, are nurtured, and protected from the weather. A mother koala will do anything to protect her precious, “Joey.”

The koala finds itself at peace whilst sitting in a tree. They spend most of their time up there and rarely on land. They particularly use trees for protection from harsh weather changes such as: snow, rain, hail, etc. The tree, is a safe haven for all koalas large or small, male or female.

Physiology

The koala in its outside appearance has areas of black and white, with a thick fur which is a grey color. The middle part of the body is stout, they have small eyes, a large nose and they can weigh from ten to thirty pounds. They have front limbs that are much longer than the back ones and have powerful claws with fingernails. They have opposable thumbs that allow them to easily grip as well as to climb. While the males and females look the same, the males are larger in size. They also have a wider face. The mature males develop a brown gland on their chest area. This allows them to leave scents behind.

When a koala is born, the females have a pouch that the newborn koalas enter immediately after birth. For the first six months the pouch will ensure safety and comfort. By contracting her stomach muscles the female koala can “zip up” the pouch.

It is known that the koala has a very small brain. They aren’t viewed as highly intelligent however they do have the ability to problem solve and to adapt on various levels. They have a very simple existence that many find to be boring. Nevertheless, the design of their body as well as their brain has allowed this species to survive for many millions of years.

Overall, the body works well for the koala. They have an excellent method of balancing themselves without any problems. They can sit upright for most of the day without fear of falling from the trees. They have a thigh muscle that is located lower on the body than for most other animals which gives them an amazing amount of strength to use for climbing.

The koala’s excellent sense of balance, lean, muscular body, and long length make it born to live life in trees. Their arms and legs are almost equal in length and their climbing strength comes from the thigh muscle joining the shin. Climbing trees is easy for the koala. Their paws are especially adapted with rough pads on the palms and soles for helping with grip on tree trunks and branches. Each paw has five claws and on the front paw, two fingers are contrasting to the other three, similar to a human thumb.

The fur of a koala is used to protect it from both high and low temperatures. It repels moisture when it rains and the color varies from light grey to brown, decorated with patches of white on the chest, neck, inside arms, legs and the ears.

An adult male Koala, which usually weights around 17 pounds to 30 pounds, and a female Koala, which weighs around 13 to 24 kilograms, have adapted to the colder climate. To do this, the heavier animals from the southern areas have increased their body weight and adapted thicker fur. An example of this are the koalas that reside in Queensland, Australia. They are noticeably smaller than the koalas that live in

Victoria since the temperature there is less cold.

Climate has greatly affected the lifestyle of the Koala. As a result of the weather patterns of their homeland, they are nocturnal, since they are less likely to lose precious moisture and energy during the night. In average, they spend eighteen to twenty hours each day resting and sleeping. With the rest of their time, Koalas feed, move around, groom, and engage themselves in social interaction.

An interesting feature about the Koalas is their nose, which is highly developed in order for them to be able to differentiate between different types of gum leaves and to detect whether the leaves are poisonous or not. Still, the Koalas digestive system is especially adapted to detoxify the poisonous chemicals in the leaves, which are thought to be produced by the gum trees. These leaves are poisonous as a way for the tree to protect itself from leaf-eating animals like insects. As a result, Koalas only eat certain types of eucalypt trees and try to avoid trees that grow on less fertile soil, since those are the most toxic.



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Edit History

- Created: February 29, 2012
- Version 1.0 submitted to CK-12: May 25, 2012
- CK-12 edits: *in progress*

11.3 *Delphinapterus leucas*



Status

in preparation

Common Name

- Beluga Whale
- White Whale

Description

Habitat

Biology

A. Cell Biology

B. Genetics

C. Evolution

D. Ecology

E. Physiology

References

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Edit History

Created: November 23, 2011

11.4 *Lemur catta*



Status

in preparation

Common Name

- Ring-Tailed Lemur

Description

Habitat

Biology

A. Cell Biology

B. Genetics

C. Evolution

D. Ecology

E. Physiology

References

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Edit History

Created: February 29, 2012

Image Sources

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Chapter 12

Understanding Biodiversity: Expeditions



CK-12 Understanding Biodiversity: Expeditions

CK-12 Understanding Biodiversity: Expeditions highlights the greatest and most famous expeditions connected with the natural history literature.

- da Gama's Sea Route to India
- Amundsen's South Pole Expedition
- Peary's Conquering of the North pole
- Cortés' Conquest of Mexico
- Przhevalsky's Discovery of Central and East Asia
- von Jacquin's Expedition to the Caribbean
- Livingstone's Exploration of Africa
- de Andrade's Exploration of Tibet
- Hudson's Voyages

- Humboldt's Expeditions
- di Mulazzo's North and South America Exploration
- Nordenskiöld's Northeast Passage
- Amundsen's Northwest passage
- Scott's South Pole Expeditions
- de Magalhães's Voyage of Circumnavigation
- Darwin's Voyage of the Beagle
- Cartier's Voyages to the New World

Image Sources

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Chapter 13

List of Contributors



Understanding Biodiversity Contributors

Table 13.1: **Kingdom Animalia**

Species	Author(s)	Affiliation		Status
<i>Loxodonta africana</i>	Steven Prado	Cleveland Initiative, Cleveland High School, Reseda, CA	Science Grover	<i>under review</i>
<i>Phascolarctos cinereus</i>	Maria Sol Raiano, Nilufar Haider and Arashjot Kaur	Cleveland Initiative, Cleveland High School, Reseda, CA	Science Grover	<i>under review</i>

Table 13.1: (continued)

Species	Author(s)	Affiliation	Status
<i>Delphinapterus leucas</i>	Alis Kachanyan, Gabrielle L. Dulys and Erin A. Vaystub	Cleveland Science Initiative, Grover Cleveland High School, Reseda, CA	<i>in preparation</i>
<i>Lemur catta</i>	Ian Osborne, Salam Qammouh and Roger Borjas	Cleveland Science Initiative, Grover Cleveland High School, Reseda, CA	<i>in preparation</i>

Table 13.2: Kingdom Plantae

Species	Author(s)	Affiliation	Status
<i>Pisum sativum</i>	Christopher Vasquez	Grover Cleveland High School, Reseda, CA	<i>under review</i>

Table 13.3: Kingdom Fungi

Species	Author(s)	Affiliation	Status
<i>Saccharomyces cerevisiae</i>	Douglas Wilkin	The CK-12 Foundation, Palo Alto, CA	<i>reviewed by CK-12</i>

Table 13.4: Kingdom Bacteria

Species	Author(s)	Affiliation	Status

Table 13.5: Kingdom Archaea

Species	Author(s)	Affiliation	Status

Table 13.6: Kingdom Protista

Species	Author(s)	Affiliation	Status

Table 13.7: **Expeditions**

Voyage	Author(s)	Affiliation	Status
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Image Sources

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Chapter 14

Understanding Biodiversity Template



14.1 Species

Common Name

Description

Habitat

14.2 Biology

A. Cell Biology

B. Genetics

C. Evolution

D. Ecology

E. Physiology

14.3 References

14.4 Attribution

Authors

Affiliation

Image Sources

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